Economic Haul Radius as Affected by Diesel Fuel Cost

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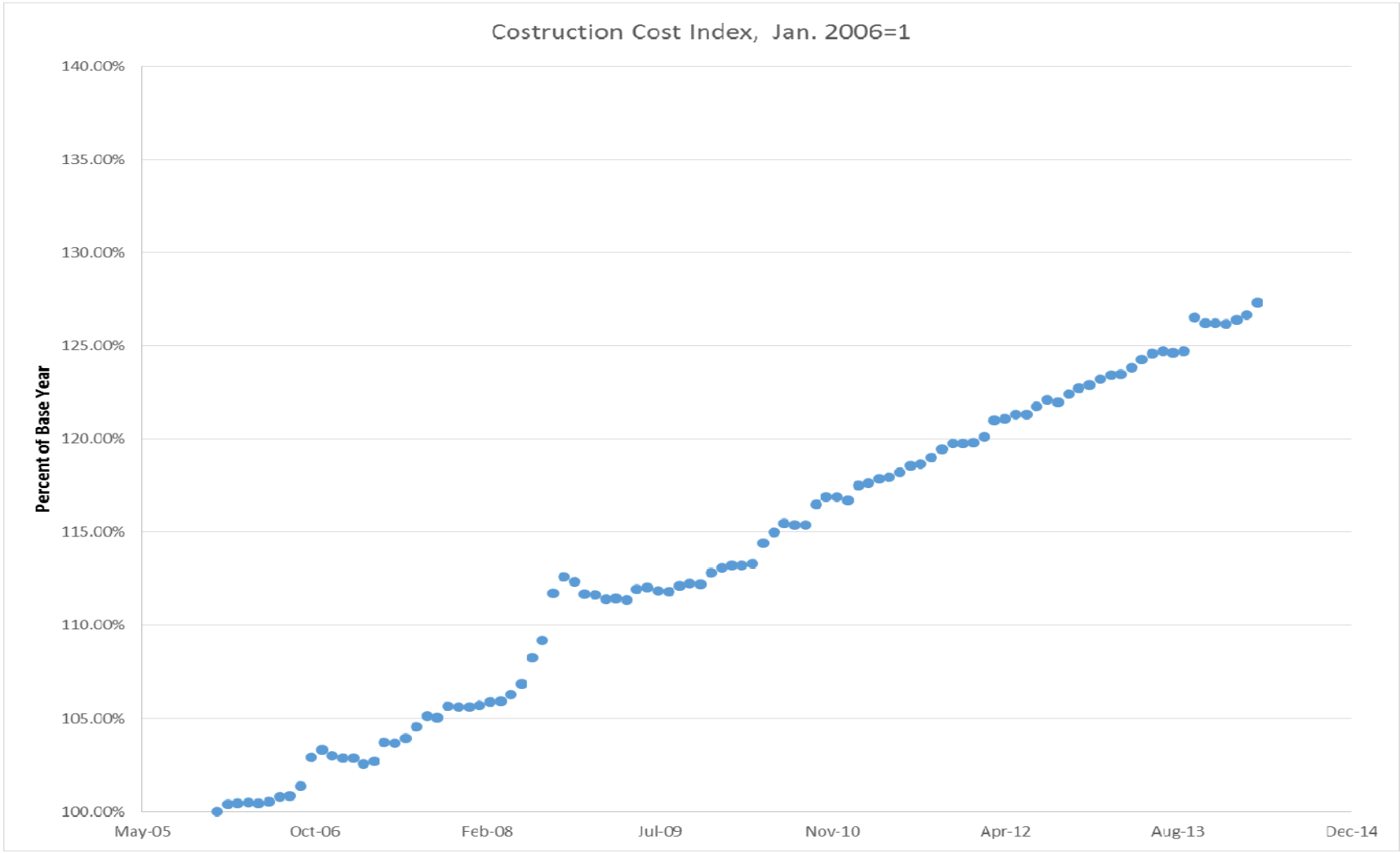
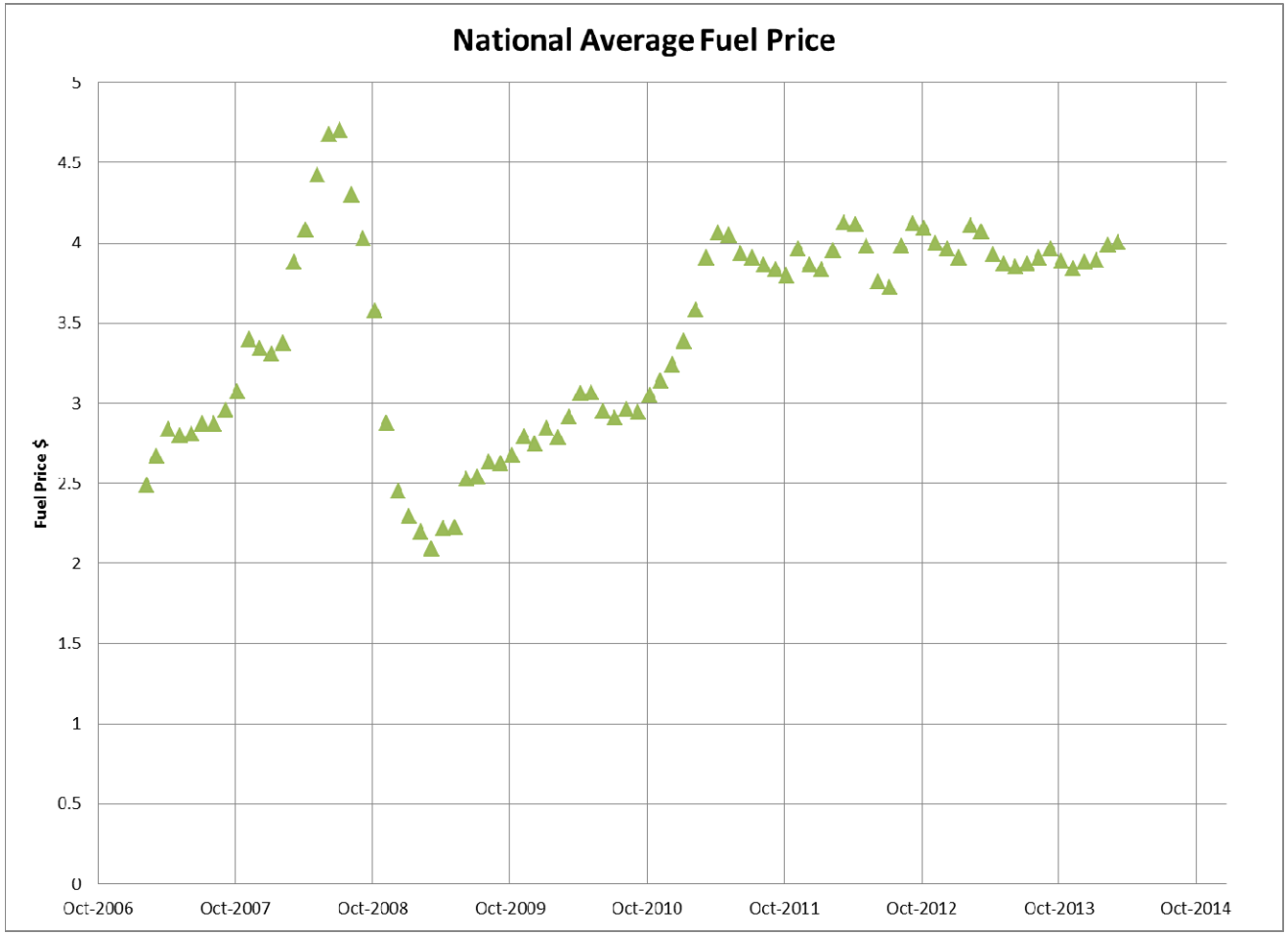
Objective

- Motivation
- Methods
- Results

Construction costs continue to increase



Fuel Price is Variable and Increasing



Aggregate

- Necessary for most construction
- Energy intensive to transport
- Variable quality
- Not all aggregates are suitable

Aggregate Quality

- Quality aggregate sources are limited

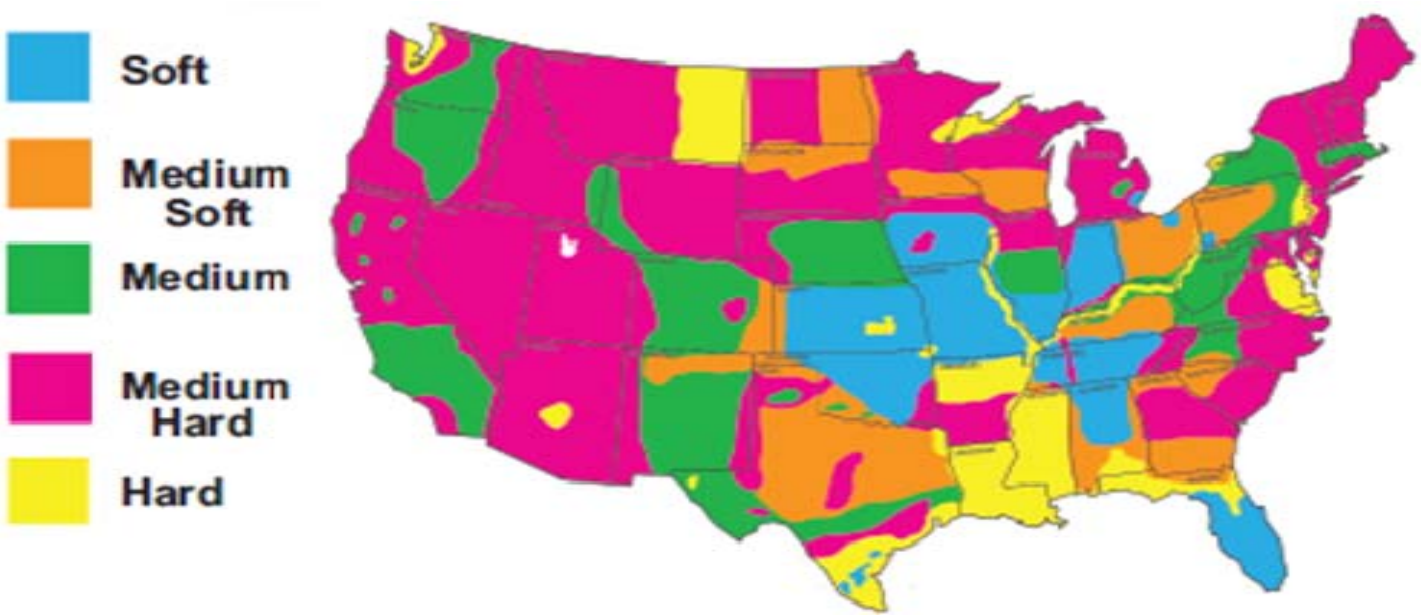
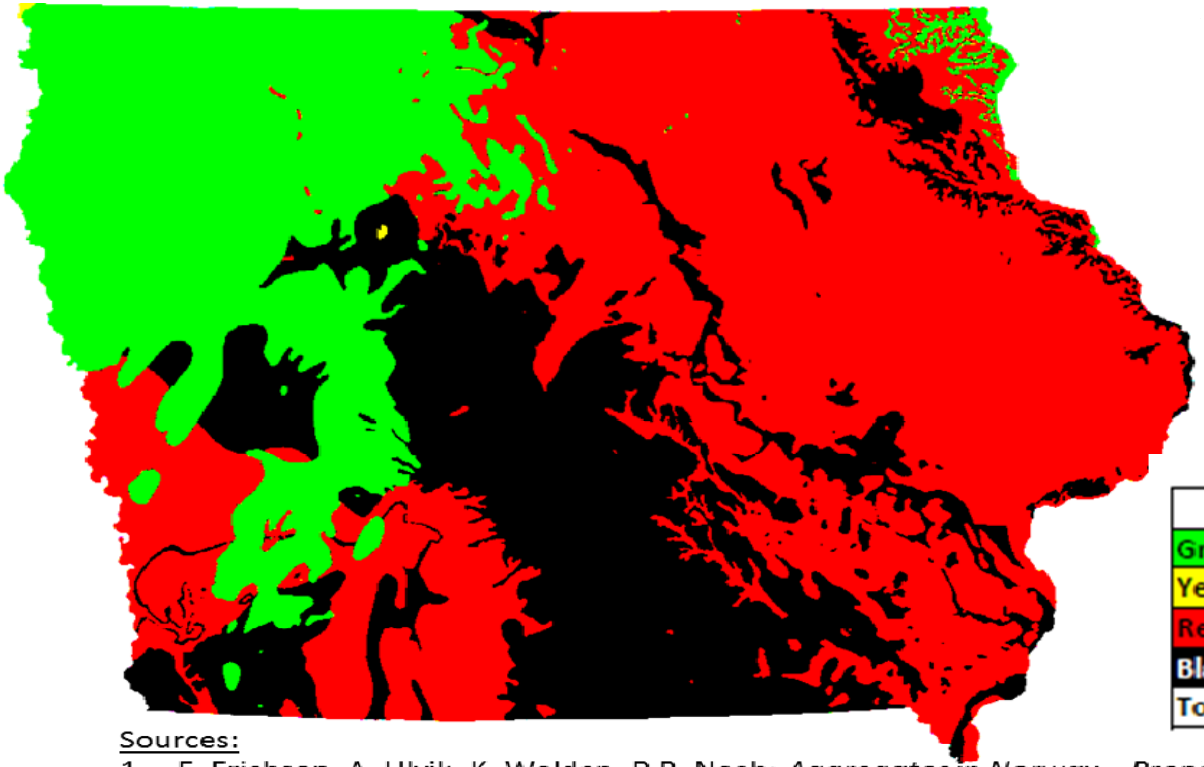


Figure 1. US Aggregate Quality Distribution

Aggregate Quality



Good Aggregates

Marginal Aggregates

Variable Aggregates

Unacceptable Aggregates

Iowa Pixel Values

	Pixel Count	% of Total
Green	34293	23.95%
Yellow	140	0.10%
Red	68629	47.94%
Black	40104	28.01%
Total	143166	

Sources:

1. E. Erichson, A. Ulvik, K. Wolden, P.R. Neeb; *Aggregates in Norway—Properties defining the quality of sand, gravel and hard rock for use as aggregate for building purposes*, 2008.
2. Missouri Geologic Map Data, http://mrdata.usgs.gov/geology/state/kml/mogeol.kmz, 2005.
3. R. Hosking. *Road aggregate and skidding*. Transport Research Laboratory State-of-the-art Review 4, 1992.
4. Drawn using Google Earth.

Haul Radius

- $Cost\ to\ Haul = \frac{\$}{Hr} Operation \times \frac{Haul\ Distance}{Haul\ Speed}$
- For economic haul: $Cost\ Haul = Cost\ Material$
- $Cost\ of\ Material = \frac{\$}{Hr} Operation \times \frac{Haul\ Distance}{Haul\ Speed}$

Haul Radius

- $Haul\ Distance = \frac{Cost\ of\ Material \times Haul\ Speed}{{}^{\$}/_{Hr}Operation}$
- Because haul cost is assumed to account for a return trip to the point of origin:
- $Haul\ Distance = 2 \times Haul\ Radius$
- Which results in: $Haul\ Radius = \frac{1}{2} \times \frac{Cost\ of\ Material \times Haul\ Speed}{{}^{\$}/_{Hr}Operation}$

Haul Radius Values

- Cost of Material
  - -Market price
- Haul Speed
  - -Assumed for project
- Cost per Hour of Operation
  - -Puerifoy Method

Puerifoy Method

- Robert L. Puerifoy

  -Text: Construction Planning, Equipment and Methods

- Method accounts for
  - Time value of money
  - Equipment life and annual use
  - Tire, maintenance, oil and fuel use
  - Interest, insurance, storage, taxes

  - Driver cost added to method for full hourly cost

Model

- Common truck chosen
  - Freightliner 122SD

- Price: $150,000
  (New)

- Specs: 505HP
  (Max)

Model

Puerifoy Cost Method				Annual	Hourly			Economic Haul				
Purchase Price	$150,000.00		Equipment Ownership	$27,456.81	$13.73			Avg. Speed	25	mph		
Salvage Value	$45,000.00		Tire Ownership	$4,711.93	$2.36			Vehicle Capacity	16	ton		
Useful Life (yrs)	7		Maintenance	-	$6.10			Material Price	$12.50	ton		
Tire Cost	$4,600.00		Fuel	-	$35.26							
Tire Life (hrs.)	2200		Lube	-	$4.57			Cost of load	$200.00			
Maintenance %	85.00%		Tires	-	$0.21							
Oil Price	$15.00		*Driver	-	$38.29			Total Dist	49.7	mi		
Fuel Price	$3.50		Total		$100.51							
Tire repair %	10.00%							Haul Rad.	24.9	mi	12mo	
FWHP	505		* Driver not included in Puerifoy Method									
Operating Factor	0.7							$/mi-ton	$0.50			
Oil Capacity	11.375											
Oil Life	640											
Hours/Year	2000											
Depreciation	$7.17											
Investment	12.05%											
Interest	5.00%		Oil Consumption	0.006	lb/hp-hr							
Insurance	4.00%		Fuel Consumption	0.0285	gal/hp-hr							
Storage and Fees	1.25%		Oil weight/volume	7.4	lb/gal							
Taxes	1.80%		P/A factor	0.21946525								
			F/A factor	0.09896525								
			Tire P/A factor	1.02433164								
	Gransberg		Fuel Cons. Gal/hr/hp	Favorable		Average		Unfavorable				
			Truck, on-highway	0.014–0.029		0.020–0.037		0.026–0.046				

Fuel Price

http://www.eia.gov/petroleum/gasdiesel/

- Stochastic model of fuel price

12mo	18mo	24mo
3.919	3.952	3.971

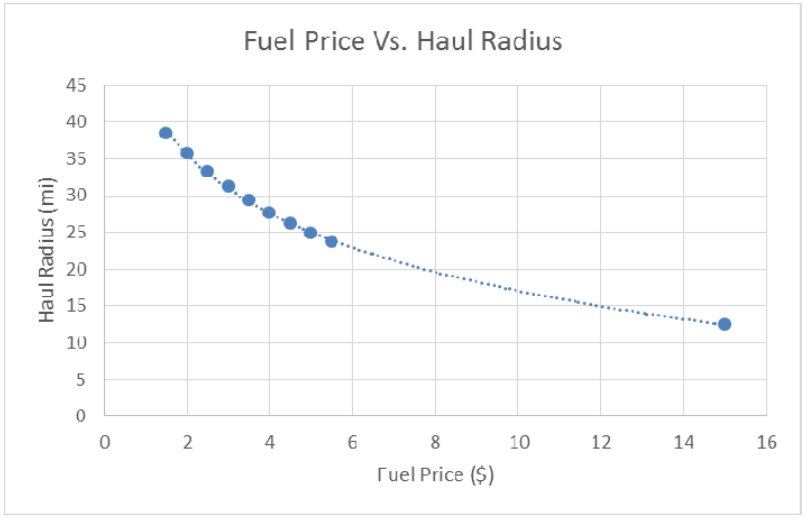
- Uses Monte Carlo Simulation
- Radius result

Haul Rad.	23.9 mi	12mo
Haul Rad.	23.8 mi	18mo
Haul Rad.	23.8 mi	24mo

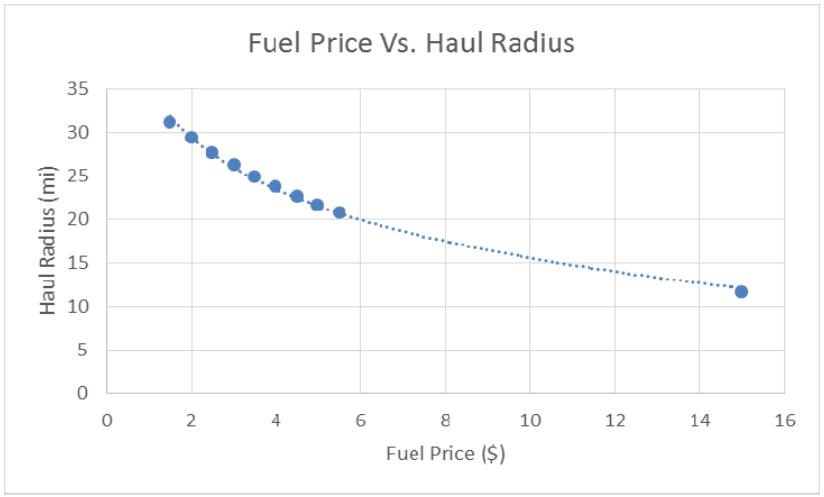
Mar-2014	4.001	4.001	4.001
Feb-2014	3.984	3.984	3.984
Jan-2014	3.893	3.893	3.893
Dec-2013	3.882	3.882	3.882
Nov-2013	3.839	3.839	3.839
Oct-2013	3.885	3.885	3.885
Sep-2013	3.961	3.961	3.961
Aug-2013	3.905	3.905	3.905
Jul-2013	3.866	3.866	3.866
Jun-2013	3.849	3.849	3.849
May-2013	3.87	3.87	3.87
Apr-2013	3.93	3.93	3.93
Mar-2013	4.068	4.068	4.068
Feb-2013		4.111	4.111
Jan-2013		3.909	3.909
Dec-2012		3.961	3.961
Nov-2012		4	4
Oct-2012		4.094	4.094
Sep-2012		4.12	4.12
Aug-2012			3.983
Jul-2012			3.721
Jun-2012			3.759
May-2012			3.979
Apr-2012			4.115
Mar-2012			4.127

Model Results

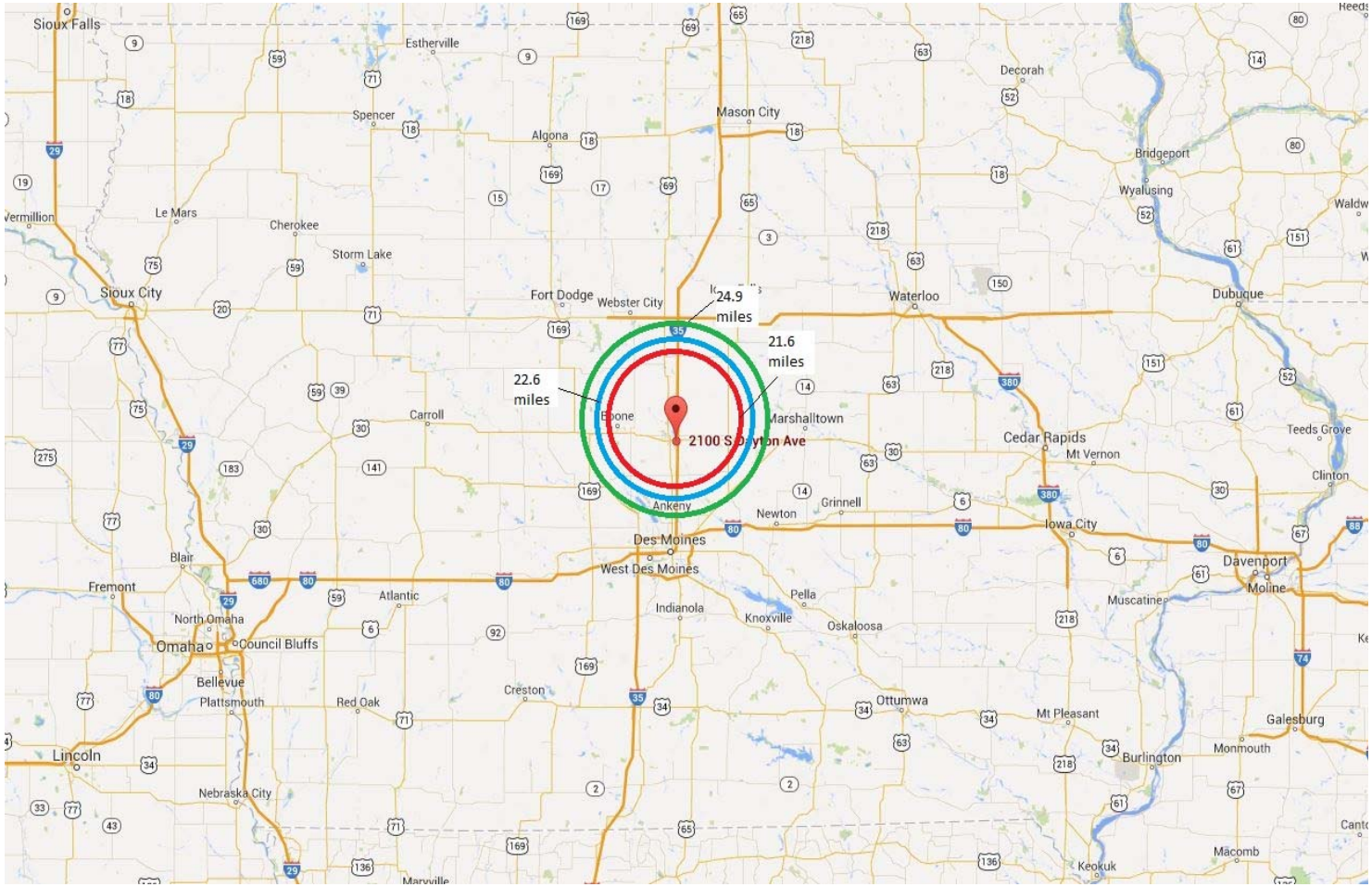
$23/Hr Driver



$38.29/Hr Driver



Haul Radius



$3.50

$4.50

$5.50

Summary

- Fuel Price affects hauling costs
- Hauling cost determines economic haul radius
- High fuel costs can cause some projects to be uneconomical
- Alternatives

Thank you!

Dr. Douglas Gransberg, PE

Yashasvi Raj